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SEPARATING EARLY LARVAE OF SCIAENIDS FROM THE WESTERN NORTH ATLANTIC: A REVIEW AND COMPARISON OF LARVAE OFF LOUISIANA AND ATLANTIC COAST OF THE U.S.

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ABSTRACT

At least 21 species of sciaenids occur along the Atlantic and Gulf coasts of the U.S. with several members of the family supporting important recreational and commercial fisheries. Although descriptive literature is available for the larvae of most sciaenids, it contains many inaccuracies and is insufficient for separating similar taxa. Close examination of critical areas of pigmentation separate most sciaenids, with several species easily recognized because of characteristic pigment patterns. *Larimus fasciatus* larvae have pigment on the anterior forebrain, anterior and posterior midbrain, posterior hindbrain, and pectoral fin. *Bairdiella chrysoura* larvae have a "cleithral swath" of pigment. Larvae of *Menticirrhus* sp. and *Cynoscion nebulosus* have palatal pigment; however, only *Menticirrhus* sp. have multiple melanophores on the nape and lack pigment immediately anterior to the cleithral symphysis. Larvae of *C. arenarius, C. nothus,* and *C. regalis* are the only taxa lacking heavy dorsal, lateral, and/or brain pigmentation that have pigment on the gular isthmus between lower jaw rami. *Micropogonias undulatus* larvae lack pigment on the anterior visceral mass whereas all other species have pigment at this location. In addition to pigmentation, morphometrics are helpful for separating several taxa from the northern Gulf of Mexico, especially *Leiostomus xanthurus* from *M. undulatus,* and *C. nothus* from *C. arenarius.* Two morphs of *C. arenarius* larvae were recognized from the northern Gulf but the taxonomic significance of this variation is uncertain.

At least 21 species of sciaenids occur along the Atlantic and Gulf coasts of the U.S. (Table 1). Several members of the family [spotted seatrout, *Cynoscion nebulosus* (Cuvier); sand seatrout, *C. arenarius* Ginsburg; weakfish, *C. regalis* (Bloch and Schneider); red drum, *Sciaenops ocellatus* (Linnaeus); black drum, *Pogonias cromis* (Linnaeus); Atlantic croaker, *Micropogonias undulatus* (Linnaeus); and spot, *Leiostomus xanthurus* Lacepede] support important recreational and commercial fisheries. Although descriptive information is available for the larvae of most species of sciaenids (Table 2), the literature contains many inaccuracies (Table 3) and lacks sufficient detail to separate similar taxa. Little is known about larvae of high-hat, *Equetus acuminatus* (Schneider); jack-knife fish, *E. lanceolatus* (Linnaeus); spotted drum, *E. umbrosus* (Jordan and Eigenmann); reef croaker, *Odontoscion dentex* (Cuvier); or sand drum, *Umbrina coroides* Cuvier. *Equetus acuminatus* and *E. umbrosus* were referred to the genus *Pareques* by Chao (1976), but Robins et al. (1980) retained *Equetus* for all species. An undescribed species of *Equetus* also occurs in the eastern Gulf of Mexico off Florida (Chao, 1976) at least through the northern Gulf of Mexico (Bruce Thompson, pers. comm.).[1] An illustration and partial description of *Equetus* sp. larvae from the Caribbean was provided by Powles and Burgess (1978) who attributed it to the genus *Pareques.*[2] Matsuura and Nakatani (1979) described *U. coroides* larvae >6.8 mm SL collected from waters off Brazil. Larvae of *O. dentex* are undescribed. Little is also known about the taxonomy and development of *Menticirrhus* larvae. Three species of

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[2] Recently described as *Pareques iwanotoi* by Miller and Woods, Bull. Mar. Sci. 1988. 43: 88–92.

Table 1. Distribution of sciaenids along the Atlantic coast of the U.S. and Gulf of Mexico*

Bairdiella chrysoura†—Gulf of Main through Gulf of Mexico to northern Mexico.
Cynoscion arenarius—Gulf coast of south Florida to the Yucatan peninsula of Mexico.
C. nebulosus—New York through Gulf of Mexico to northern Mexico.
C. nothus—Chesapeake Bay through Gulf of Mexico to the Yucatan peninsula of Mexico.
C. regalis—Gulf of Maine to possibly lower Gulf coast of south Florida.
Equetes sp.—North Carolina south through Gulf of Mexico and Caribbean southward.‡
E. acuminatus—Chesapeake Bay through Florida Keys and southward.
E. lanceolatus—North Carolina to northeastern Gulf of Mexico, and western Gulf of Mexico.
E. punctatus—Atlantic coast of Florida through Keys and southward.
E. umbrosus—Chesapeake Bay through Gulf of Mexico to northern Mexico.
Larimus fasciatus—Massachusetts through Gulf of Mexico to northern Mexico.
Leiostomus xanthurus—Massachusetts through Gulf of Mexico to the Yucatan peninsula of Mexico.
Menticirrhus americanus—New York through Gulf of Mexico to the Yucatan peninsula of Mexico.
M. littoralis—Chesapeake Bay through Gulf of Mexico to the Yucatan peninsula of Mexico.
M. saxatilis—Maine through Gulf of Mexico to the Yucatan peninsula of Mexico.
Micropogonias undulatus—Maine through Gulf of Mexico to the Yucatan peninsula of Mexico.
Odontoscion dentex—Atlantic and Gulf coasts of Florida.
Pogonias cromis—Maine through Gulf of Mexico to the Yucatan peninsula of Mexico.
Sciaenops ocellatus—Massachusetts through Gulf of Mexico to northern Mexico.
Stellifer lanceolatus—Chesapeake Bay through Gulf of Mexico to northern Mexico.
Umbrina coroides—Altantic coast of south Florida and extreme western Gulf of Mexico.

* Data compiled from Irwin (1971); Weinstein and Yerger (1976); Chao (1978); Powles and Stender (1978); Darovec (1983).
† *Bairdiella batabana* and *B. sanctaeluciae* infrequently occur off south Florida and the Keys.
‡ Recently described as *Pareques iwamotoi* by Miller and Woods. Bull. Mar. Sci. 1988. 43: 88–92.

Menticirrhus (Irwin, 1971) are known to occur in the western North Atlantic: *Menticirrhus americanus* (Linnaeus), *M. littoralis* (Holbrook), and *M. saxatilis* (Bloch and Schneider). A fourth species, *M. focaliger* Ginsburg, was synonymized with *M. saxatilis* by Irwin (1971), and this synonymy has been followed by Chao (1978), and Robins et al. (1980).

There have been several compilations of information on sciaenid larvae from the Atlantic coast but none that included *C. arenarius,* a species endemic to the Gulf of Mexico. Johnson (1978) assembled published information for Atlantic taxa, and Fahay (1983) organized and summarized descriptive data. Powles and Stender (1978) summarized taxonomic literature, compiled meristic data, and provided notes on spawning and original descriptive observations. However, Powles and Stender's work contained no illustrations and they did not examine larvae of *L. xanthurus, P. cromis,* or *S. ocellatus* <3.9 mm SL. Therefore, a comprehensive, comparative treatment of sciaenid larvae that emphasizes characters for separating species is needed to overcome problems in specimen identification (Powles, 1981). The objectives of this paper are to provide morphometric data on early larvae of sciaenids from the northern Gulf of Mexico; review, update, and summarize the literature on early larval development; and compare pigmentation and early developmental morphology of corresponding species from the Atlantic coast and northern Gulf of Mexico off Louisiana.

Materials and Methods

Sciaenid larvae were obtained from plankton collections taken off southeastern Louisiana (Sabins, 1973; Daniels, 1977; Fruge, 1977; Walker, 1978; Ditty, 1986). All specimens were preserved in 4% buffered formalin. Collections in neritic continental shelf waters were made with a 60-cm paired, opening and closing bongo-type BNF-1 plankton sampler[3] (0.363-mm mesh), 61-cm MARMAP bon-

[3] Tareq and Co., 8460 SW 68th St., Miami, Florida 33143.

Table 2. Published illustrations and descriptive information on identification of early life history stages of sciaenids from the Atlantic coast of the U.S. and Gulf of Mexico; ND means no data (Reference: Powles and Stender, 1978)

Taxa	Eggs	Yolk-sac larvae	Early larvae[1]	Late larvae[2]	Juveniles	Recapitulation
Bairdiella chrysoura	18, 32	18, 32	15, 18, 26, 27, 32	18, 26, 27, 32	18, 26, 32	6, 16, 19, 28
Cynoscion arenarius			3, 4, 7, 15	3, 4, 7, 15		
C. nebulosus	5, 9	5	4, 5, 12, 15, 26, 30	4, 12, 21, 26, 30	12, 21, 26, 32	6, 9, 16, 19
C. nothus			26, 30	7, 12, 26, 30	12, 26	16
C. regalis	10, 32	32	22, 23, 26, 28, 30	19, 22, 26, 30, 31	13, 26, 32	6, 13, 16, 19, 28
Equetes spp.			25	25		26
Larimus fasciatus			12, 26, 27	12, 26, 27	12	6, 16
Leiostomus xanthurus	24	8, 24	8, 24, 26	8, 11, 15, 19, 21, 24, 26	11, 13, 21, 26, 32	6, 16, 19, 28
Menticirrhus americanus			12, 15, 26	12, 15, 26	12, 26, 32	6, 16, 19, 28
M. littoralis				12	12, 32	16
M. saxatilis	32	32	23, 28	12, 15	12, 32	6, 16, 19, 28
Micropogonias undulatus		8	8, 11, 26	8, 11, 19, 21, 26	11, 21, 26, 32	6, 16, 19, 28
Odontoscion dentex	ND	ND	ND	ND	ND	ND
Pogonias cromis	17, 29	17, 28	15, 17, 21, 26	15, 17, 21	21	6, 16, 19, 28
Sciaenops ocellatus	14	14	14, 15, 21, 26	14, 15, 21, 26	21, 32	6, 16, 19
Stellifer lanceolatus			26, 27	12, 26, 27	26, 32	6, 16
Umbrina coroides				20	20	

[1] <5.0 mm SL.
[2] 5.0–15.0 mm SL.
3 Cowan, 1985.
4 Daniels, 1977.
5 Fable et al., 1978.
6 Fahay, 1983.
7 Finucane et al., 1977.
8 Fruge and Truesdale, 1978.
9 Guest and Gunter, 1958.
10 Harmic, 1958.
11 Hildebrand and Cable, 1930.
12 Hildebrand and Cable, 1934.
13 Hildebrand and Schroeder, 1928.
14 Holt et al., 1981.
15 Jannke, 1971.
16 Johnson, 1978.
17 Joseph et al., 1964.
18 Kuntz, 1914.
19 Lippson and Moran, 1974.
20 Matsuura and Nakatani, 1979.
21 Pearson, 1929.
22 Pearson, 1941.
23 Perlmutter, 1939.
24 Powell and Gordy, 1980.
25 Powles and Burgess, 1978.
26 Powles and Stender, 1978.
27 Powles, 1980.
28 Scotton et al., 1973.
29 Simmons and Breuer, 1962.
30 Stender, 1980.
31 Tracy, 1908.
32 Welsh and Breder, 1924.

Table 3. Suspected misidentifications from the larval sciaenid literature and probable corrected identifications.[1] Numbers in parentheses after authors' names are sizes of larva in question. All measurements are in mm SL unless otherwise noted; '?' indicates both original and probable identifications uncertain (Reference: Powles and Stender, 1978)

	Probable identification						
Original identification	*Bairdiella chrysoura*	*Cynoscion nebulosus*	*Larimus fasciatus*	*Leiostomus xanthurus*	*Menticirrhus americanus*	*Menticirrhus saxatilis*	*Stellifer lanceolatus*
Bairdiella chysoura	2?						3
Cynoscion nebulosus					4		
C. regalis		5					
Leiostomus xanthurus				6?			
Menticirrhus americanus		7				8, 9, 10	11
Stellifer lanceolatus			12				

[1] Most of these inaccuracies were also repeated by Scotton et al. (1973), Lippson and Moran (1974), and Johnson (1978) in their respective summaries of sciaenid larvae.
2 Jannke, 1971 (2.0).
3 Jannke, 1971 (5.0).
4 Hildebrand and Cable, 1934 (2.0 and 2.5).
5 Tracy, 1908 (12.5 mm TL).
6 Hildebrand and Cable, 1930 (1.7, 3.2, 4.0).
7 Hildebrand and Cable, 1934 (1.7).
8 Welsh and Breder, 1924 (2.65, 2.7, 3.9 mm TL, adult).
9 Scotton et al., 1973 (2.7).
10 Jannke, 1971 (6.0).
11 Hildebrand and Cable, 1934 (5.8).
12 Hildebrand and Cable, 1934 (1.8, 2.5, 3.3).

gos (Posgay et al., 1968) (0.505-mm mesh), and/or 1-m plankton nets or sled-mounted 1-m nets (both of 0.505-mm mesh). Other collections were from 1-m plankton net (0.505-mm mesh) or hand-pulled beam trawl (Renfro, 1963) samples in Caminada Pass, a tidal pass that joins Barataria Bay with the Gulf of Mexico.

Measurements were made to the nearest 0.01 mm with an ocular micrometer in a dissecting microscope. Definition of measurements, terminology, and abbreviations used in the text are as follows: Standard length (SL)—snout to notochord tip in preflexion larvae or to posterior edge of developing hypurals in flexion larvae. Total length (TL)—snout to posterior margin of finfold or to distal tip of developing caudal rays. Eye diameter—anterior to posterior margin of pigmented portion of eye. Preanal length—snout tip to vertical line through posterior margin of anus. Body depth—depth measured perpendicular to longitudinal body axis at anterior margin of pectoral base. Anus to anal fin gap—gap between anus and anterior margin of anal fin base. Epimere—segment of muscle lying dorsal to the mid-lateral septum. Hypomere—segment of muscle lying ventral to the mid-lateral septum.

The early larval period was separated into two developmental stages: preflexion and flexion (Ahlstrom et al., 1976). Morphometrics are given by developmental stage for larvae collected from the northern Gulf of Mexico off Louisiana (Tables 4 and 5). Myomere counts include all those between the anteriormost and posteriormost myoseptum, plus the urostylar segment. Epimeres and hypomeres are numbered consecutively according to their associated myomere. The placement (i.e., myomere number) of melanophores along the dorsal and/or ventral midline in *C. arenarius, C. nothus,* and *C. regalis* is related to a corresponding epimere or hypomere. Since fin ray counts facilitate identification of postflexion larvae, emphasis was placed on characters that allow separation of larvae <5 mm SL. No attempt was made to completely review developmental pigmentation. Areas of pigmentation useful for separating early larvae of sciaenids are summarized in Table 6. Representative larvae were illustrated with the aid of a camera lucida.

Larval Characters

Larimus fasciatus Holbrook

Pigmentation.—Larvae of *L. fasciatus* are characterized by pigment on the pectoral fin base at all sizes which extends onto the proximal finfold by 3 mm SL. Between 2–2.5 mm SL, *L. fasciatus* collected off Louisiana had brain pigment only on the posterior mid- and hindbrains, respectively (Fig. 1A). By 3 mm SL, they also had pigment on the surface of the anterior forebrain and anterior midbrain similar to that in Powles and Stender (1978) (Fig. 1B). Early larvae (<3 mm SL) have a melanophore at the tip of the dentary, one or two on the gular isthmus between lower jaw rami, a large melanophore on the visceral mass just ventral to the pectoral fin base, and also on the ventral surface of the visceral mass at the origin

Table 4. Body proportions (mean, standard deviation, and range) of preflexion larvae of sciaenids from the northern Gulf of Mexico off Louisiana; expressed as percent standard length (SL)

Species	Size range (mm SL)	N	Eye diameter	Preanal length	Body depth
Bairdiella chrysoura	3.10 ± 0.56 2.30–4.20	15	10.28 ± 0.52 9.42–11.31	40.22 ± 1.34 38.08–42.60	29.49 ± 1.73 26.09–32.72
Cynoscion arenarius A	3.20 ± 0.66 2.45–4.20	10	9.57 ± 0.45 8.92–10.43	47.16 ± 2.38 42.86–50.00	31.31 ± 2.01 28.57–34.74
C. arenarius B	3.30 ± 0.73 2.20–4.30	10	9.57 ± 0.66 8.33–10.45	45.85 ± 2.13 42.92–48.81	30.00 ± 2.55 25.00–32.88
C. nebulosus	2.89 ± 0.45 2.25–3.38	10	10.42 ± 0.78 9.18–11.77	48.67 ± 2.72 44.94–54.80	26.54 ± 1.91 24.30–30.40
C. nothus	2.73 ± 0.37 2.26–3.12	7	11.25 ± 0.54 10.62–12.18	50.39 ± 1.84 47.11–52.22	34.86 ± 1.97 32.43–38.46
Larimus fasciatus	2.74 ± 0.33 2.04–3.17	10	13.02 ± 1.20 12.08–15.89	51.57 ± 3.22 47.08–57.20	36.45 ± 2.87 30.83–40.91
Leiostomus xanthurus	3.19 ± 0.59 2.35–4.05	10	11.37 ± 0.37 10.86–11.81	47.26 ± 3.19 42.81–52.19	30.33 ± 1.84 27.08–33.06
Menticirrhus sp. A	2.95 ± 0.49 2.09–3.72	15	11.08 ± 0.82 9.42–12.30	48.77 ± 4.91 42.06–55.80	34.06 ± 2.43 29.70–38.89
Micropogonias undulatus	2.92 ± 0.53 2.22–3.84	10	10.74 ± 0.97 9.63–12.61	47.71 ± 3.17 43.83–53.63	29.55 ± 1.66 27.93–32.95
Pogonias cromis	3.04 ± 0.34 2.64–3.72	10	9.80 ± 0.61 8.67–10.51	47.25 ± 4.27 37.72–52.30	26.21 ± 2.23 24.00–28.49
Sciaenops ocellatus	3.44 ± 0.45 2.69–4.22	10	9.51 ± 1.08 7.85–11.90	48.25 ± 2.23 44.44–52.26	30.88 ± 3.34 25.50–34.74
Stellifer lanceolatus	3.03 ± 0.49 2.28–3.84	15	9.76 ± 0.56 8.76–11.07	41.25 ± 2.08 37.72–46.03	30.76 ± 4.01 24.12–35.12

of the developing pelvic fin bases as described for larvae >3 mm SL by Powles and Stender (1978). Along the ventral midline between the anus and notochord tip, there is a row of about 10–12 melanophores in larvae <2.5 mm SL, usually the sixth of which is larger than the others. These postanal melanophores along the ventral midline decrease in number as larvae develop. By 3.5 mm SL, there are only two or three postanal melanophores ventrally, the largest of which are near the origin and termination of the developing anal fin base (Powles and Stender, 1978).

Morphometry and Comparisons.—*Larimus fasciatus* resemble no other larval sciaenid. Larvae are robust, deep-bodied, and have large eyes. In general, eye diameter and body depth in *L. fasciatus* larvae from the northern Gulf are greater than in any other sciaenid examined (Tables 4 and 5).

Micropogonias undulatus (Linnaeus)

Pigmentation.—Larvae of *M. undulatus* are characterized by lack of pigment on the anterior surface of the visceral mass between cleithra at all sizes (Lippson and Moran, 1974; Fruge and Truesdale, 1978; Powles and Stender, 1978). Larvae <3 mm SL from the northern Gulf have a series of 11–22 postanal melanophores along the ventral midline, the largest of which is midway between the anus and notochord tip (Fruge and Truesdale, 1978). By 3–3.5 mm SL, there are 12–15 ventral postanal melanophores and these decrease in number with increasing SL. As the anal fin base develops, there is pigment in the anus-anal fin gap immediately

Table 5. Body proportions (mean, standard deviation, and range) of flexion larvae of sciaenids from the northern Gulf of Mexico off Louisiana; expressed as percent standard length (SL)

Species	Size range (mm SL)	N	Eye diameter	Preanal length	Body depth
Bairdiella chrysoura	4.23 ± 0.24 3.84–4.56	10	10.88 ± 0.62 9.53–11.43	43.68 ± 1.58 41.24–45.96	33.61 ± 1.40 31.31–35.35
Cynoscion arenarius A	4.74 ± 0.39 4.25–5.20	5	8.87 ± 0.34 8.51–9.41	48.40 ± 1.49 46.16–50.00	31.71 ± 1.40 30.77–34.12
C. arenarius B	4.65 ± 0.29 4.25–5.05	5	8.98 ± 0.56 8.24–9.78	48.86 ± 2.31 46.74–51.49	32.90 ± 0.87 31.58–33.70
C. nebulosus	4.05 ± 0.25 3.70–4.34	5	10.32 ± 1.23 9.23–12.17	57.93 ± 2.23 55.53–61.54	28.16 ± 1.94 25.70–30.49
C. nothus	4.47 ± 0.32 4.15–5.00	5	10.74 ± 0.81 9.42–11.67	50.60 ± 3.75 46.27–55.35	35.21 ± 1.16 33.41–36.10
Larimus fasciatus	3.63 ± 0.46 3.12–4.20	5	13.12 ± 1.92 11.46–15.38	56.69 ± 4.92 51.82–62.38	39.26 ± 2.54 36.20–42.31
Leiostomus xanthurus	4.53 ± 0.22 4.28–4.80	5	11.29 ± 0.76 10.10–12.13	47.66 ± 0.68 47.08–48.72	31.59 ± 0.88 30.61–32.95
Menticirrhus sp. A	4.12 ± 0.28 3.72–4.56	10	10.54 ± 0.58 9.57–11.56	55.34 ± 2.91 51.66–61.74	34.16 ± 2.44 31.97–38.03
Menticirrhus sp. B	4.0	1	12.50	68.75	41.25
Micropogonias undulatus	4.19 ± 0.23 3.84–4.44	5	9.21 ± 0.42 8.80–9.68	52.08 ± 2.18 50.00–55.36	31.73 ± 1.39 30.18–33.85
Pogonias cromis	4.56 ± 0.28 4.13–5.11	8	8.95 ± 0.91 7.78–10.00	51.28 ± 3.82 45.57–55.00	28.30 ± 2.37 24.94–31.00
Sciaenops ocellatus	4.34 ± 0.26 4.08–4.64	5	9.51 ± 0.49 9.05–10.22	47.75 ± 1.84 45.69–49.34	29.02 ± 2.22 27.29–32.84
Stellifer lanceolatus	4.06 ± 0.23 3.72–4.38	10	9.35 ± 0.36 8.80–9.82	43.59 ± 2.55 39.39–47.22	35.03 ± 1.89 32.36–38.73

anterior to the first anal spine, a melanophore near both the origin of the anal fin base where the first or second anal ray will originate and the fin base termination, and usually 4–6 smaller melanophores posterior to the base. There is a gap in postanal pigment along the middle of the anal fin base in larvae >4 mm SL similar to that outlined by Powles and Stender (1978). Larvae of *M. undulatus* <5 mm SL are relatively sparsely pigmented and lack postanal pigment both dorsally and laterally (Fig. 2).

Morphometry and Comparisons.—Lack of pigment on the anterior visceral mass between cleithra immediately separates *M. undulatus* larvae at all sizes from all other sciaenids for which larvae are known. By 4.5 mm SL, *M. undulatus* from off Louisiana can also be separated from *L. xanthurus* by eye diameter and preanal length (Fruge and Truesdale, 1978). Eye diameter was >10% SL and preanal length <49% SL in *L. xanthurus* compared to <10% SL and >50% SL, respectively, in *M. undulatus* (Table 5; Figs. 2 and 3). In general, my observations agree with those of Fruge and Truesdale (1978) and Powles and Stender (1978) for these two species except for the size at which preanal length is useful in separating *M. undulatus* from *L. xanthurus*. Fruge and Truesdale (1978) and Powles and Stender (1978) found that preanal length was not diagnostic until about 8.5 mm SL when preanal length was greater in *M. undulatus* than in *L. xanthurus*. However, I found preanal length diagnostic by 4.5 mm SL. I also found pigment along the ventrolateral surface of the dentary in most *M. undulatus* larvae <3 mm SL, but only

Table 6. Areas of pigmentation useful for separating early larvae (<5 mm SL) of sciaenids from the northern Gulf of Mexico off Louisiana. Abbreviations are as follows: (PAL) palatine; (D) dentary; (I) isthmus; (P_1) pectoral fin base; (LM) lateral midline externally; (SDO) soft dorsal fin origin; (DAFT) dorsal midline above anal fin termination; (CS) anterior to cleithral symphysis; (AVM) anterior visceral mass; (GAP) anus to anal fin gap; (AFO) anal fin origin; (MAB) middle of anal fin base; (AFT) anal fin termination; (+) present; (−) absent; (±) some.

Species	PAL	Lower jaw D	Lower jaw I	P_1	LM	NAPE[a]	SDO	DAFT	CS	AVM	GAP	AFO	MAB	AFT
Bairdiella chrysoura	−	+	−	−	−	+	−	±	+	+	+	+	−	+
Cynoscion arenarius A	−	±	+	−	−	+	−	−	+	+	+	−	+	−
C. arenarius B	−	±	+	−	−	+	−	+	+	+	+	−	+	−
C. nebulosus	+	+	+	−	+	+	−	+	+	+	+	+	+	+
C. nothus	−	±	+	−	−	+	−	−	+	+	+	+	−	+
Larimus fasciatus	−	+	+	+	−	+	−	−	+	+	−	+	−	+
Leiostomus xanthurus	−	+	−	−	−	+	−	−	+	+	+	+	+	+
Menticirrhus spp.	+	±	+	±	+[b]	+[c]	−	+[d]	−	+	−	+	+	+
Micropogonias undulatus	−	±	−	−	−	+	−	−	+	−	+	+	−[e]	+
Pogonias cromis	−	+	−	−	+	+	−	+	+	+	+	+	+	+
Sciaenops ocellatus	−	+	±	−	±[f]	+	+	+	+	+	+	+	+	+
Stellifer lanceolatus	−	+	−	−	+[g]	±	−	+[g]	+	+	±	+	−	+

[a] Nape pigment usually becomes embedded in musculature as larvae increase in SL.
[b] Not pigmented until about 3 mm SL in morph A larvae.
[c] Multiple melanophores.
[d] Not pigmented until about 3.5 mm SL in morph A larvae.
[e] Gap in pigment along anal fin base at >4 mm SL.
[f] Internal pigment above notochord by about 4 mm SL.
[g] Pigment in these areas by about 3.5 mm SL.

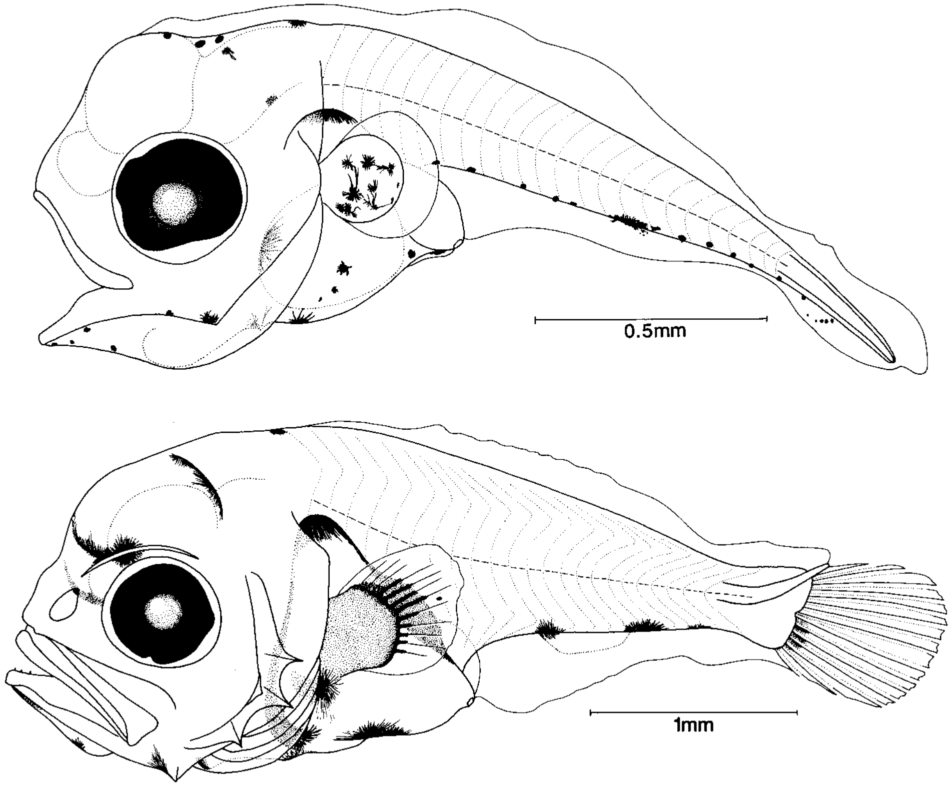

Figure 1. *Larimus fasciatus*: A—2.0 mm SL; B—3.8 mm SL.

at the tip of the dentary in most *L. xanthurus*. Fruge and Truesdale (1978) did not comment on pigment along the dentary in either species. In addition to lack of pigment on the anterior visceral mass between cleithra in *M. undulatus*, they can also easily be separated from superficially similar *C. arenarius* and *C. nothus* larvae by lack of pigment on the gular isthmus between lower jaw rami in *M. undulatus*. *Cynoscion* spp. have pigment at this location.

Leiostomus xanthurus Lacepede

Pigmentation.—Larvae <3 mm SL of *L. xanthurus* from the northern Gulf have a row of 11–22 similar size postanal melanophores along the ventral midline and pigment on the anterior visceral mass between cleithra (Fruge and Truesdale, 1978). As the anal fin base develops, there is a melanophore in the anus-anal fin gap, one each near the origin, along the base, and near the termination of the fin base, and usually three to four melanophores ventrally along the caudal peduncle (Fruge and Truesdale, 1978; Powles and Stender, 1978). Larval *L. xanthurus* are relatively sparsely pigmented and lack postanal pigment both dorsally and laterally (Fig. 3).

Morphometry and Comparisons.—Larvae of *L. xanthurus* from the northern Gulf are separated from superficially similar *C. arenarius* and *C. nothus* by lack of pigment on the gular isthmus between lower jaw rami in *L. xanthurus*. Generally, preanal length separates *L. xanthurus* from both *Bairdiella chrysoura* and *Stellifer*

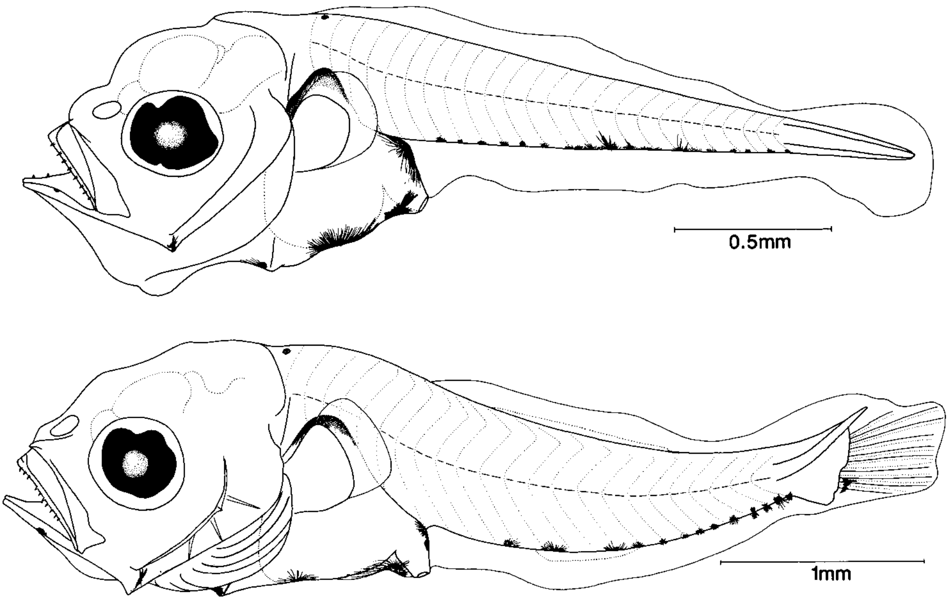

Figure 2. *Micropogonias undulatus*: A—2.8 mm SL; B—4.1 mm SL.

lanceolatus; *L. xanthurus* has a greater preanal length than either species (Tables 4 and 5). Larvae of *B. chrysoura* also have a characteristic cleithral swath of pigment that *L. xanthurus* lacks (refer to *B. chrysoura* section for discussion of "swath"). In addition, *L. xanthurus* has a larger eye than *S. lanceolatus* (Tables 4 and 5) and there is pigment near the middle of the anal fin base in *L. xanthurus* that *S. lanceolatus* lack (Table 6).

Sciaenops ocellatus (Linnaeus)

Pigmentation.—Early larvae (2–3 mm SL) of *S. ocellatus* from off Louisiana are characterized by a melanophore at three locations along the dorsal midline: near the nape, dorsal to the anus, and about midway between the anus and notochord tip. Ventrally, the largest melanophores are immediately posterior to the anus and about midway between the anus and notochord tip (Fig. 4A). There are also usually three to five smaller melanophores posterior to the termination of the anal fin base. As the dorsal and anal fin bases develop, the largest melanophores along the dorsal midline are near the origin of the soft dorsal and above the termination of the anal fin base; the largest postanal melanophores along the ventral midline are in the anus-anal fin gap and near the termination of the anal fin base similar to those described in Pearson (1929) and Powles and Stender (1978) (Fig. 4B). Along the lateral midline, there is an external melanophore dorsal to the anus in most larvae from both the Atlantic coast (Powles and Stender, 1978) those I examined from off Louisiana east of the Mississippi River, and although not necessarily on both sides of the body, in larvae off Texas (G. Joan Holt, pers. comm.).[4] However, Pearson's (1929) 4.5 mm TL wild-caught larva collected off Texas, and few wild-caught larvae <5 mm SL that I examined from

[4] G. Joan Holt, University of Texas, Marine Science Institute, Port Aransas Marine Laboratory, Port Aransas, Texas 78373.

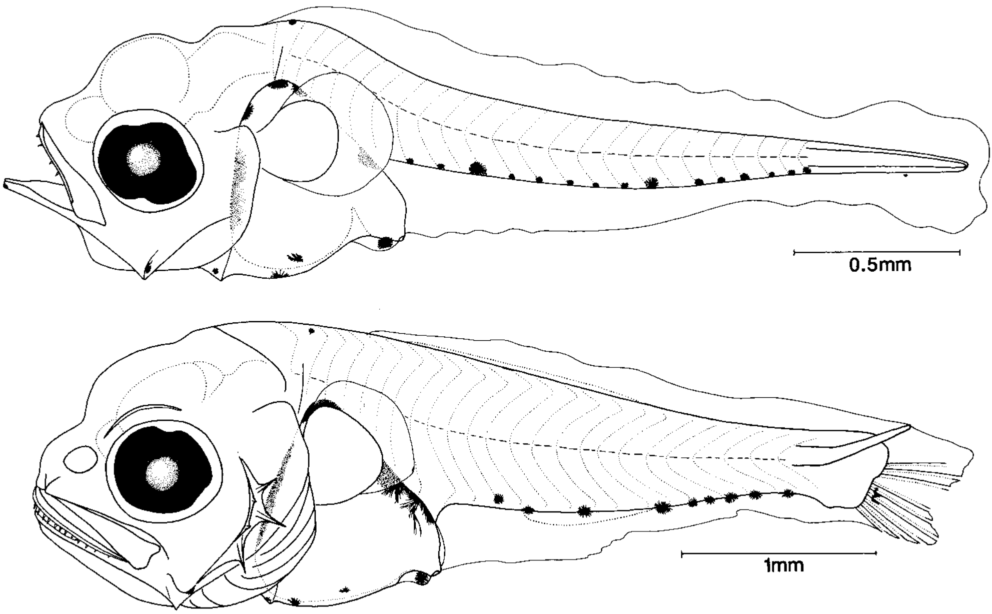

Figure 3. *Leiostomus xanthurus*: A—2.8 mm SL; B—4.3 mm SL.

off Louisiana west of the Mississippi River, had pigment in the lateral midline dorsal to the anus. There is internal pigment above the notochord by about 4–4.5 mm SL in larvae off Louisiana similar to that illustrated by Jannke (1971) and discussed by Powles and Stender (1978) and Holt et al. (1981). Most wild-caught *S. ocellatus* larvae off Texas (G. Joan Holt, pers. comm.)[3] and all those examined by Powles and Stender (1978) have a melanophore on the gular isthmus between lower jaw rami. Pigment was seldom found at this location in *S. ocellatus* larvae I examined from off Louisiana, although pigment was consistently present at both the tip and along the lateral surface of the anterior one-third of the dentary.

Morphometry and Comparisons.—Larvae of *S. ocellatus* from the northern Gulf of Mexico are easily separated from those of similar *P. cromis* by their seasonal occurrence. *Sciaenops ocellatus* occur primarily from August to October and *P. cromis* from December to April (Ditty, 1986). Also, *S. ocellatus* larvae have pigment near the origin of the soft dorsal fin base at all sizes and postanal internal pigment dorsal to the notochord by 4 mm SL that *P. cromis* lacks (Figs. 4 and 5). Early larvae of *S. ocellatus* are separated from those of all other sciaenids by the placement and number of melanophores along the dorsal midline (Table 6). Jannke's (1971) illustration of a 3.5 mm SL *S. ocellatus* larva does not show pigment at the three locations in the dorsal midline (i.e., near the nape, dorsal to anus, and midway between the anus and notochord tip) nor immediately posterior to the anus-anal fin gap characteristic of larvae off Louisiana and as described by Powles and Stender (1978). Pearson (1929) stated that the yolk-sac was present in *S. ocellatus* until 4–5 mm TL, although his illustration and description of a 4.5 mm TL larva shows a fairly well-developed caudal fin and dorsal and anal anlagen. No *S. ocellatus* larvae >2.2 mm SL examined in this study had a yolk-sac.

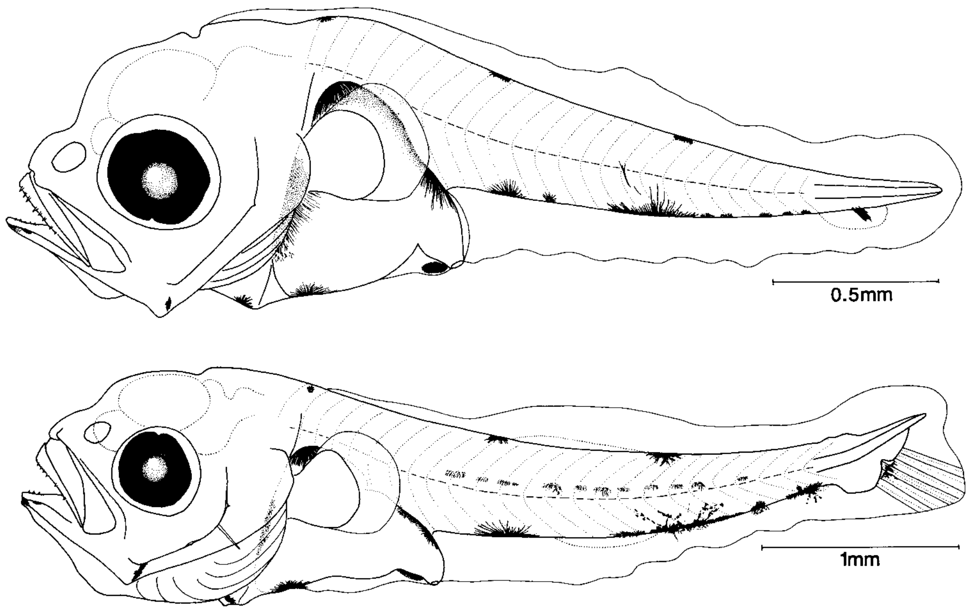

Figure 4. *Sciaenops ocellatus*: A—2.8 mm SL; B—4.4 mm SL.

Pogonias cromis (Linnaeus)

Pigmentation.—Early larvae (2.6–3 mm SL) of *P. cromis* from off Louisiana and those of Joseph et al. (1964) are characterized by pigment at two locations along the dorsal midline: near the nape and about midway between the anus and notochord tip. Along the lateral midline, there is a diffuse, external melanophore dorsal to the anus in most larvae and several melanophores along the ventral midline between the anus and notochord tip (Fig. 5A). *Pogonias cromis* also have pigment midway along the lateral surface of the dentary and at its tip. As the dorsal and anal fin bases develop, the largest postanal melanophores are in the anus-anal fin gap, near the middle of the anal fin base, and in the dorsal midline above the termination of the anal fin base (Fig. 5B). Larvae of *P. cromis* from Joseph et al. (1964), Powles and Stender (1978), and those that I examined, lacked pigment near the soft dorsal origin. There was no internal pigment above the notochord in larvae <5 mm SL from the Atlantic coast (Powles and Stender, 1978) or from the northern Gulf. Postanal melanophores along the dorsal and ventral midlines in *P. cromis* are usually dendritic.

Morphometry and Comparisons.—*Pogonias cromis* and *S. ocellatus* are not easily confused with other sciaenids and can be separated from each other by characters discussed under *S. ocellatus*. Pearson (1929) did not illustrate in his 4.5 mm TL *P. cromis* larva or discuss the location of melanophores along the dorsal midline noted by subsequent authors (Joseph et al., 1964; Powles and Stender, 1978) or found in material I examined. However, Pearson (1929) did indicate that the yolk-sac was still present in his 4.5 mm TL *P. cromis* larva, and Scotton et al. (1973) stated that a yolk-sac was present in larvae of 5–6 mm SL. Joseph et al. (1964) and this study found a yolk-sac only in *P. cromis* larvae <3 mm SL.

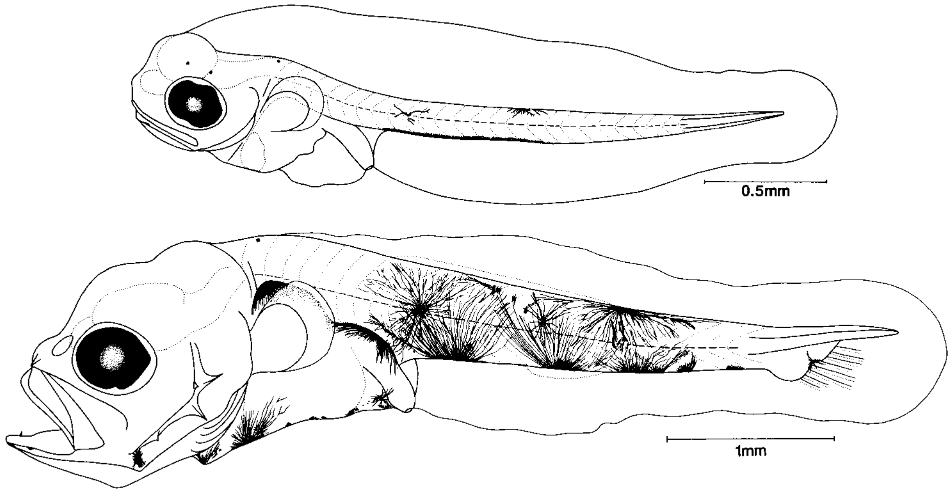

Figure 5. *Pogonias cromis*: A—2.7 mm SL; B—5.2 mm SL.

Bairdiella chrysoura (Lacepede)

Pigmentation.—Larvae of *B. chrysoura* <5 mm SL are recognized by a "swath" (Powles and Stender, 1978) of pigment roughly paralleling the cleithrum. This swath consists of pigment embedded in the nape musculature, internal pigment in the otic region ventral to the hindbrain, on the air bladder and anterior visceral mass between cleithra, and external pigment at the cleithral symphysis (Fig. 6). Although melanophores in these areas are usually expanded, in some larvae they are occasionally contracted so that a continuous swath is indistinct. Along the ventral midline, there is a series of small, evenly spaced postanal melanophores, the largest of which is about two-thirds the distance to the notochord tip. As the anal fin base develops, there are one or two melanophores in the anus-anal fin gap, one at both the anal fin origin and at its termination, respectively, and several posterior to the anal fin base (Powles, 1980). Some *B. chrysoura* larvae from the northern Gulf also have a melanophore in the dorsal midline above the termination of the anal fin base like those of Kuntz (1914), Welsh and Breder (1924), and Powles and Stender (1978) from the Atlantic coast, but neither Powles (1980) nor I found pigment near the origin of the dorsal fin by 5 mm SL as stated in Kuntz (1914). Larvae of *B. chrysoura* have pigment midway along the ventrolateral surface of the dentary at all sizes. There is no postanal pigment laterally (Powles, 1980; Powles and Stender, 1978).

Morphometry and Comparisons.—In the northern Gulf of Mexico, *B. chrysoura* larvae <5 mm SL can be separated from most other sciaenids, except *S. lanceolatus,* by preanal length. *Bairdiella chrysoura* have the shortest preanal length (Tables 4 and 5). Larvae of *B. chrysoura* are difficult to separate from those of *S. lanceolatus* when the pigment of the cleithral swath in *B. chrysoura* is contracted. However, in *B. chrysoura,* pigment usually covers the entire anterior visceral mass and there is internal pigment in the otic region ventral to the hindbrain. *Stellifer lanceolatus* larvae lack internal pigment ventral to the hindbrain, and pigment on the anterior visceral mass between cleithra is not as extensive in *S. lanceolatus* as in *B. chrysoura* (Figs. 6 and 7). By 4 mm SL, larvae of these two species from

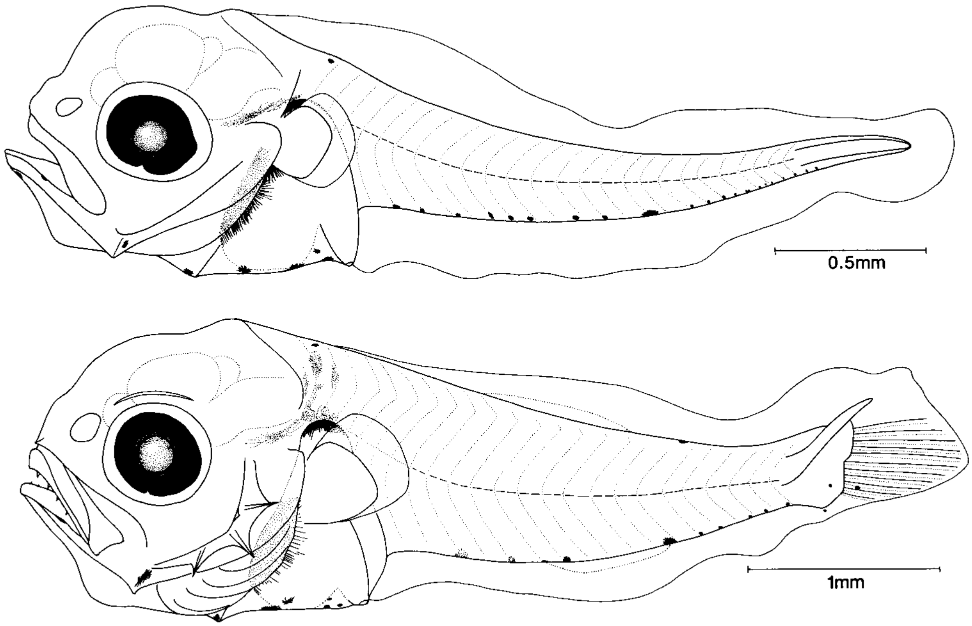

Figure 6. *Bairdiella chrysoura*: A—2.9 mm SL; B—4.3 mm SL.

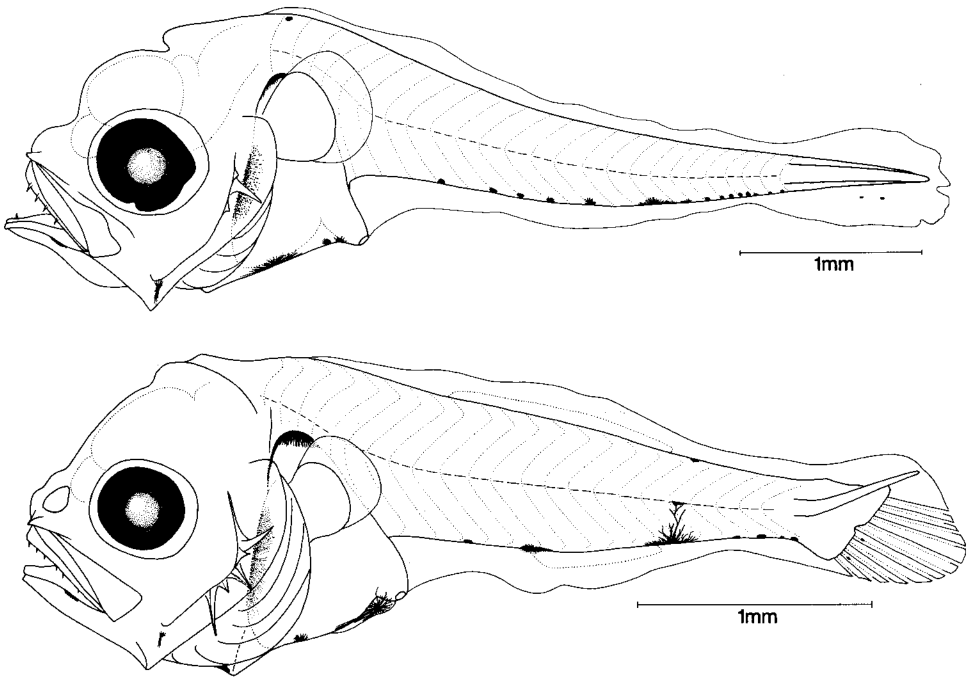

Figure 7. *Stellifer lanceolatus*: A—2.5 mm SL; B—3.7 mm SL.

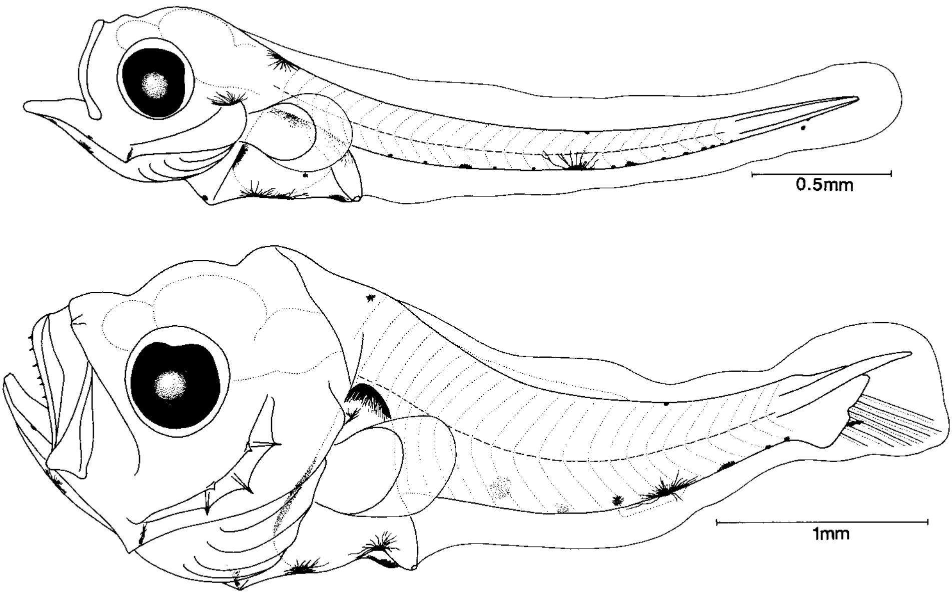

Figure 8. *Cynoscion regalis*: A—2.8 mm SL; B—4.1 mm SL.

the northern Gulf can also be separated by eye diameter (usually >10% SL in *B. chrysoura* and <10% SL is *S. lanceolatus*) and location of pigment along the anal fin base (Table 6). In addition, the melanophore near the termination of the anal fin base radiates dorsally toward the lateral midline by about 3.5 mm SL in *S. lanceolatus* but not in *B. chrysoura*. *Bairdiella chrysoura* are easily separated from the species of *Cynoscion* by the lack of pigment on the gular isthmus between lower jaw rami in the former that is present in the latter.

Stellifer lanceolatus (Holbrook)

Pigmentation.—Larvae of *S. lanceolatus* from off Louisiana have pigment midway along the ventrolateral surface of the dentary at all sizes. Early larvae <3 mm SL have a row of postanal melanophores along the ventral midline, the largest of which is located about two-thirds the distance to the notochord tip (Fig. 7A). As larvae increase in size, ventral postanal pigment is usually restricted to along the developing anal fin base with a prominent melanophore near the fin base origin, another near its termination, and usually one or two smaller melanophores along the caudal peduncle similar to that in Powles (1980). The larger of the two prominent melanophores along the anal fin base is near its termination. This melanophore near the termination of the anal fin base radiates dorsally (both internally and externally) and is often connected to pigment in the lateral midline by about 3.5 mm SL (Fig. 7B). *Stellifer lanceolatus* examined by Powles (1980) lacked pigment in the anus-anal fin gap by 3.5–4 mm SL, whereas most <4.5 mm SL from off Louisiana had internal pigment in the musculature of the gap. There is a melanophore in the dorsal midline above the terminal melanophore of the anal fin base in most *S. lanceolatus* larvae >2.9 mm SL from the Atlantic coast (Powles, 1980), whereas pigment did not occur at the aforementioned location in larvae off Louisiana until >3.5 mm SL.

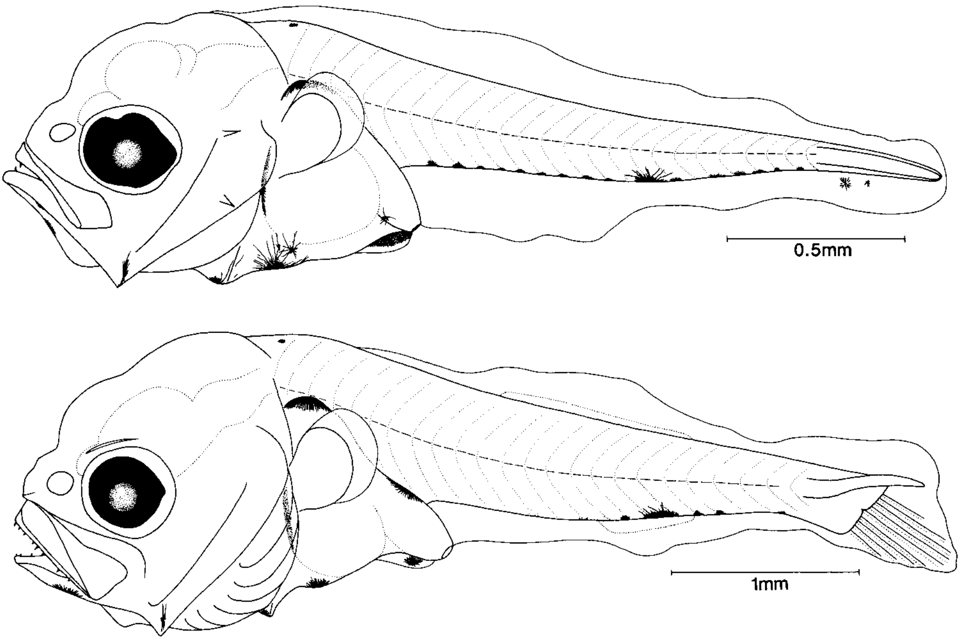

Figure 9. *C. arenarius* 'A': A—2.6 mm SL; B—4.8 mm SL.

Morphometry and Comparisons.—Preanal length in larvae of *S. lanceolatus* <5 mm SL is usually less than that of corresponding sizes of *Cynoscion* spp., and *S. lanceolatus* has pigment midway along the dentary and not on the gular isthmus between lower jar rami found in the species of *Cynoscion.* Both eye diameter and body depth were greater for Atlantic coast than northern Gulf *S. lanceolatus.* Eye diameter was >10.5% SL and body depth usually >35% SL in preflexion larvae of Atlantic *S. lanceolatus* (Powles, 1980), whereas I found in northern Gulf specimens that eye diameter was usually <10.5% SL and body depth usually <35% SL. Likewise, in flexion *S. lanceolatus,* eye diameter was usually >10% SL and body depth >38% SL in Atlantic specimens (Powles, 1980) compared to <10% SL and usually <37%, respectively, in my specimens (Tables 4 and 5).

Cynoscion arenarius Ginsburg and *C. regalis* (Bloch and Schneider)

Pigmentation.—Larvae of *C. arenarius* from the northern Gulf and those of *C. regalis* from the Atlantic coast (Stender, 1980) are recognized by pigment on the gular isthmus between lower jaw rami and relatively sparse external body pigmentation. Larvae of *C. arenarius* <3 mm SL have a row of usually 15–18 postanal melanophores along the ventral midline, the largest of which is about midway between the anus and notochord tip. In larvae of *C. regalis* (Stender, 1980) and those of *C. arenarius* that I examined, the largest postanal melanophore along the ventral midline is on hypomere 16–17; Daniels (1977) did not determine the location (i.e., myomere) of this melanophore in her *C. arenarius* larvae. The postanal melanophores along the ventral midline decrease in number with increasing SL, until at >3.5 mm SL there are one or two melanophores buried in the musculature of the anus-anal fin gap (one of which may be near the anal fin

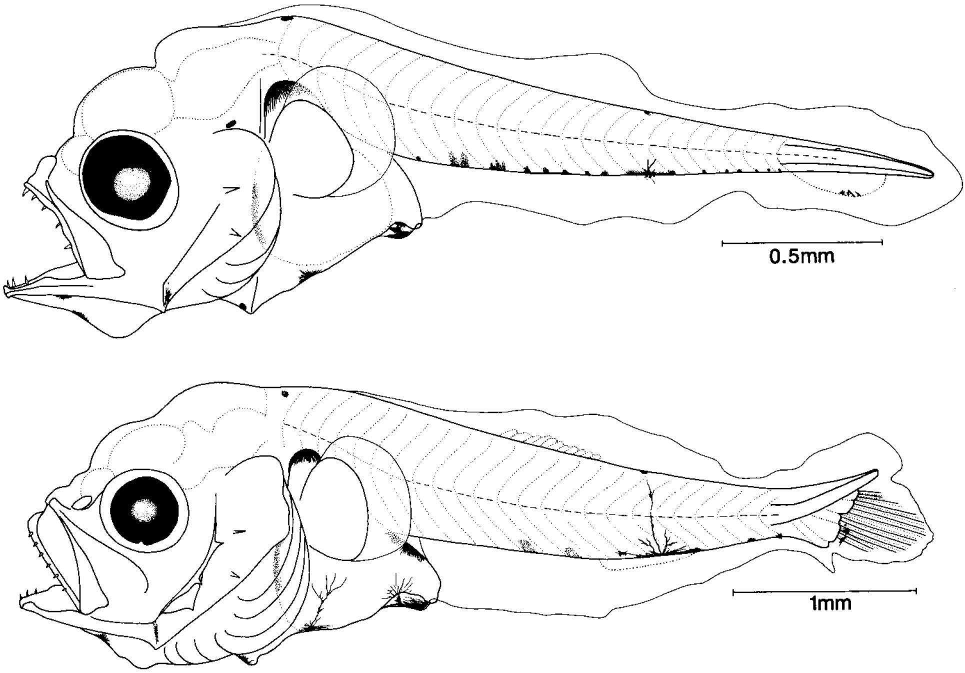

Figure 10. *C. arenarius* 'B': A—2.8 mm SL; B—4.5 mm SL.

origin), one near the middle to posterior one-third of the anal fin base, and two or three along the caudal peduncle in both *C. arenarius* (Daniels, 1977) and *C. regalis* (Powles and Stender, 1978). Larvae of *C. regalis* from the Atlantic coast also have a melanophore in the dorsal midline (epimere 17) where the dorsal fin will terminate (Stender, 1980) (Fig. 8). Two morphs of *C. arenarius* larvae were recognized in the northern Gulf of Mexico, one without (morph A; Fig. 9) and the other with (morph B; Fig. 10) a small melanophore in the dorsal midline (epimere 17) above the largest postanal melanophore of the ventral midline (Ditty, 1984; Cowan, 1985). In northern Gulf *C. arenarius,* the largest ventral melanophore is also usually more dendritic in morph B than in morph A, with a branch of pigment sometimes extending to the dorsal midline. Cowan (1985) found additional pigment differences between morphs of *C. arenarius,* only one of which was useful for separating larvae <5 mm SL. He recognized a morph I which consistently had only one melanophore on the preanal finfold at all sizes and a morph II which always had two or three. His morphs I and II were my A and B, respectively.

Morphometry and Comparisons.—There is some confusion as to the systematic status of *C. arenarius.* Ginsburg (1929) considered *C. arenarius* from the Gulf of Mexico and *C. regalis* from the Atlantic coast of the U.S. as distinct species or at least subspecies. Mohsin (1973) supported recognition of *C. arenarius* and *C. regalis* as separate species based on slight osteological differences. However, Weinstein and Yerger (1976) gave electrophoretic and distributional evidence that *C. arenarius* was a subspecies of *C. regalis.* Although there was little difference in corresponding morphometrics between the two morphs of *C. arenarius* larvae <5 mm SL (Tables 4 and 5), Cowan separated *C. arenarius* morph I from II at larger

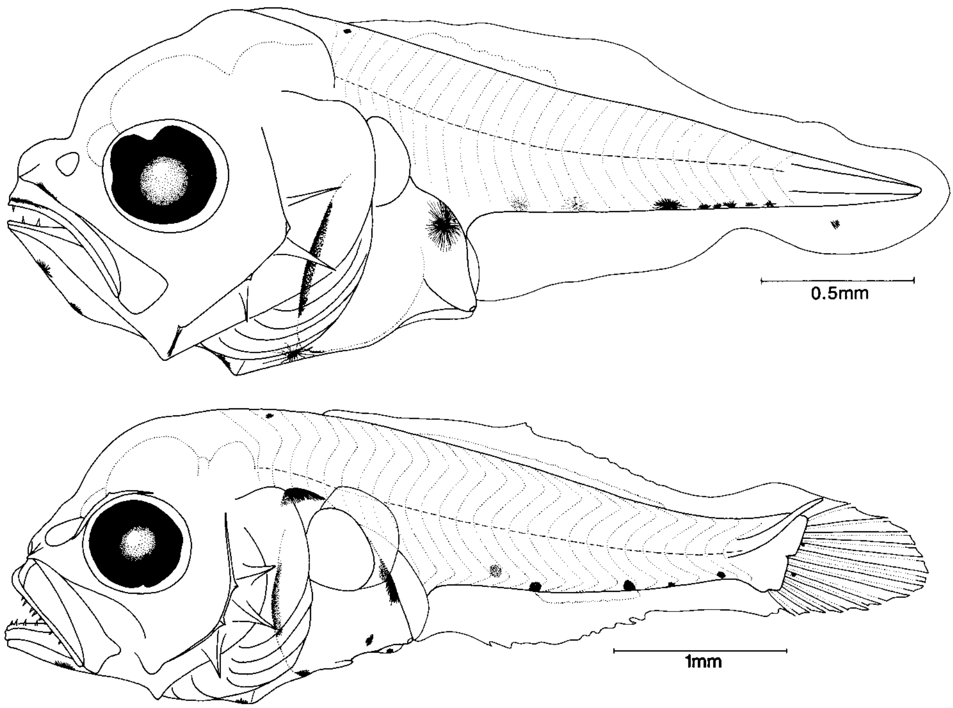

Figure 11. *C. nothus*: A—3.0 mm SL; B—4.7 mm SL.

sizes (>5 mm SL) by body depth, growth rate, and size at which lateral pigmentation occurred. The location of both the largest ventral melanophore along the anal fin base and that of the postanal dorsal midline melanophore in morph B (hypomeres 16–17 and epimere 17, respectively) was similar to that found by Stender (1980) for Atlantic *C. regalis* larvae.

Jannke (1971) provided the first illustrations of *C. arenarius* larvae but neither he nor Finucane et al. (1977) commented on morphology or pigmentation. Jannke's illustration (1971, p. 104, fig. A) showed pigment in the dorsal midline above the expanded ventral melanophore and two or three melanophores in the preanal finfold similar to that of morph II in Cowan (1985). However, Jannke (1971) did not illustrate dorsal pigment in his 3.5 mm SL *C. arenarius* (p. 104, fig. B), although this larva also had several melanophores in the preanal finfold. Daniels (1977) also noted "pigment dorsal to the ventral stellate melanophore near the middle of the anal fin base" in some *C. arenarius* near 4 mm SL, but did not illustrate this pigment until 7.5 mm SL and did not recognize separate morphs. Her description is inadequate to separate *C. arenarius* from *C. nothus* or from *C. regalis.* Pigment was not noted in the aforementioned dorsal location in *C. regalis* larvae until >6.5 mm SL by Pearson (1941) or until 10.5 mm SL by Scotton et al. (1973). A more thorough comparison of *C. arenarius* morphs with each other and with *C. regalis* larvae are needed.

The 4.6 mm SL *C. regalis* in Johnson (1978, p. 194, fig. 114C) that was credited to Perlmutter (1939) was actually by Pearson (1941). Fahay (1983) also mistakenly credited Pearson's 4.6 mm SL *C. regalis* to Perlmutter (1939). Measurements used by Pearson (1941) in his description of *C. regalis* were based on those "to

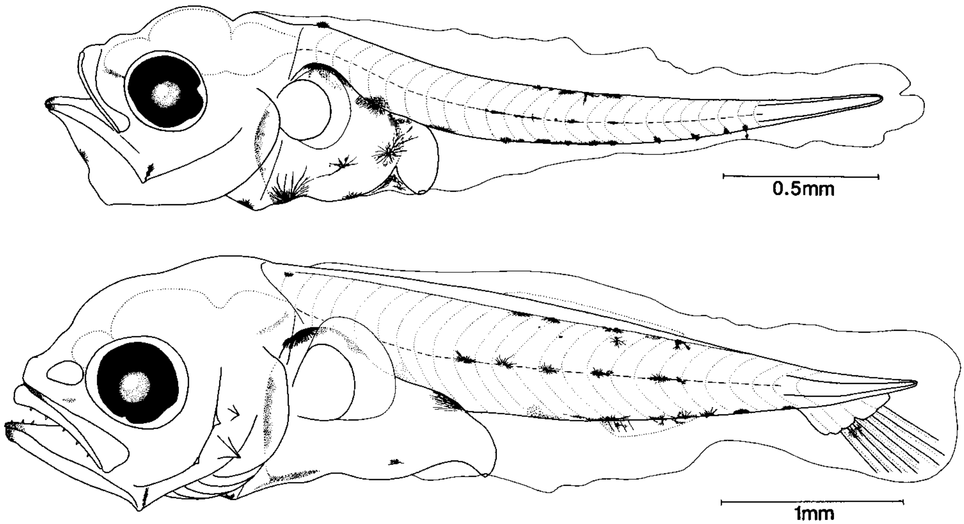

Figure 12. *C. nebulosus*: A—2.6 mm SL; B—4.2 mm SL.

the end of the notochord" (i.e., SL) and not TL as indicated by Johnson (1978). Likewise, the 32 mm TL *C. regalis* (p. 196, fig. 116A) in Johnson credited to Pearson (1941) was originally from Welsh and Breder (1924).

Cynoscion nothus (Holbrook)

Pigmentation.—Like those of *C. arenarius* and *C. regalis,* larvae of *C. nothus* from both the Atlantic coast (Stender, 1980) and northern Gulf of Mexico are recognized by pigment on the gular isthmus between lower jaw rami and relatively sparse external body pigmentation, although *C. nothus* are distinguished from its congeners by placement of postanal melanophores ventrally. Larvae <3 mm SL from off Louisiana have a row of postanal melanophores along the ventral midline, the largest of which is between the anus and notochord tip (hypomeres 19–20) similar to that described by Stender (1980). As the anal fin base develops, there is an internal melanophore in the musculature of the anus-anal fin gap (hypomere 12), external melanophores near both the origin (hypomeres 14–15) and termination (hypomeres 19–20) of the anal fin, and several posterior to the anal fin base. In *C. nothus* larvae from the Atlantic coast (Stender, 1980), the external melanophore near the anal fin base origin was on hypomere 13. *Cynoscion nothus* lack dorsal pigment except for a melanophore on the nape and there is no lateral pigment posterior to the anus (Fig. 11).

Morphometry and Comparisons.—Although there are meristic (27 myomeres in *C. nothus* versus 25 in *C. regalis* and *C. arenarius*) and pigmentation differences, morphometrics are not useful for distinguishing between larvae of *C. nothus* and *C. regalis* on the Atlantic coast (Stender, 1980). However, in the northern Gulf of Mexico, morphometrics are useful for separating *C. arenarius* from *C. nothus.* In general, *C. nothus* have a larger eye, longer preanal length, and deeper body than corresponding size *C. arenarius* (Tables 4, 5; Figs. 9, 10, 11). Larvae of *C. nothus* can also be separated from those of both *C. arenarius* morph B and *C. regalis* by pigment in the dorsal midline of these latter two taxa. *Cynoscion nothus* larvae are separated from all other sciaenids by myomere number, presence of

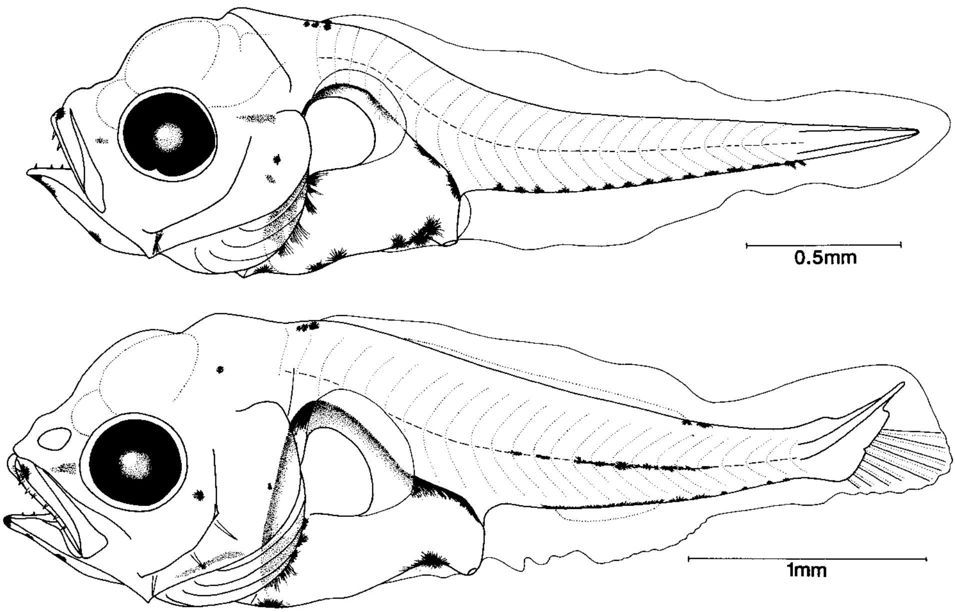

Figure 13. *Menticirrhus* sp. 'A': A—2.8 mm SL; B—3.7 mm SL.

pigment on the gular isthmus between lower jaw rami, and/or lack of pigment on the palatines such as is found in larvae of *Menticirrhus* sp. and *C. nebulosus* (Table 6).

Cynoscion nebulosus (Cuvier)

Pigmentation.—Larvae of *C. nebulosus* are characterized by internal pigment on the palatines, and external pigment along the dorsal, lateral, and ventral midlines between the anus and caudal peduncle at all sizes (Fig. 12). They also have pigment on the nape (Daniels, 1977), near the anterior tip of the dentary, and on the gular isthmus between lower jaw rami (Daniels, 1977; Stender, 1980). *Cynoscion nebulosus* larvae examined by Stender (1980) from the Atlantic coast lacked nape pigment. By 2.5 mm SL, there is a row of internal melanophores dorsal to the notochord and pigment scattered throughout the musculature. As *C. nebulosus* larvae increase in size, melanophores are added along the dorsal and ventral midlines; these melanophores coalesce to form continuous horizontal bands of pigment along the midlines of the body. By 4 mm SL, pigment on the premaxillary, palatines, operculum behind the eye, internally in the otic region ventral to the hind brain, and along the lateral midline, forms a mediolateral stripe from the snout to the caudal peduncle (Daniels, 1977; Fable et al., 1978; Stender, 1980).

Morphometry and Comparisons.—*Cynoscion nebulosus* larvae can easily be separated from those of all other sciaenids, except the species of *Menticirrhus,* at all sizes by pigment on the palatines in *C. nebulosus. Cynoscion nebulosus* larvae can be separated from those of *Menticirrhus* spp. at all sizes by body-depth; *Menticirrhus* spp. are usually much deeper-bodied (Tables 4 and 5). In addition, *Menticirrhus* sp. larvae lack pigment anterior to the cleithral symphysis (Powles and Stender, 1978), whereas *C. nebulosus* have pigment at this location. Neither Fable

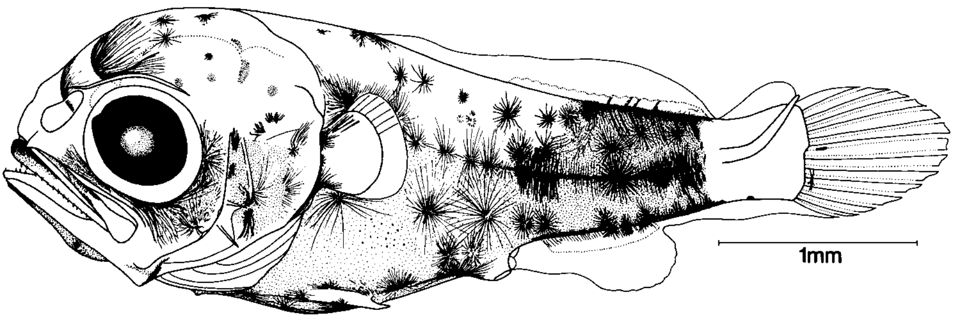

Figure 14. *Menticirrhus* sp. 'B': 4.0 mm SL.

et al. (1978) nor Hildebrand and Cable (1934) commented on palatal pigment in *C. nebulosus* larvae, although the latter authors did illustrate pigment at this location on their 3.2 mm SL specimen.

Menticirrhus spp.

Pigmentation.—Larvae of *Menticirrhus* sp. are characterized by pigment on the palatines at all sizes, two or three melanophores on the gular isthmus between lower jaw rami, multiple melanophores on the nape, and lack of pigment anterior to the cleithral symphysis (Hildebrand and Cable, 1934; Powles and Stender, 1978). I recognized two morphs (A and B) of *Menticirrhus* in collections off Louisiana (Figs. 13 and 14). Early larvae <3 mm SL of morph A from off Louisiana have a row of discrete, punctate, melanophores of similar size along the ventral midline between the anus and notochord tip. As the anal fin base develops, these melanophores coalesce to form a band of pigment extending along the ventral midline from near the anus almost to the caudal peduncle. Along the lateral midline, a row of melanophores extends from above the anus to about halfway to the notochord tip in Atlantic coast larvae >2.5 mm SL (Powles and Stender, 1978) but not until 3 mm SL in morph A larvae from off Louisiana. Lateral midline pigment extends further posteriorly as larvae increase in size. In the dorsal midline of specimens I examined and those of Powles and Stender (1978), there are several melanophores along the termination of the soft dorsal fin base by about 3.5 mm SL, and these increase in number as larvae increase in size. Only a single specimen of *Menticirrhus* morph B (4 mm SL) was recognized in collections[5] and I am unable to unequivocably establish whether larvae of morph B will also have multiple melanophores on the nape and lack pigment at the cleithral symphysis as did morph A. However, pigmentation of this specimen of morph B was much more extensive than in larvae of morph A of comparable size (Figs. 13A, B, 14).

Morphometry and Comparisons.—Published descriptions of *Menticirrhus* larvae are inadequate to reliably distinguish among the species because of mixing of species and illustrations in the literature and lack of sufficient comparative material (Powles and Stender, 1978). Larvae of my morph A resemble those of *Menticirrhus* sp. discussed by Powles and Stender (1978), and as described and illustrated by Hildebrand and Cable (1934) as *M. americanus.* The specimen of morph B had

[5] SEAMAP, 1982 Gulf of Mexico Biological Data Set. National Marine Fisheries Service, Southeast Fisheries Center. Ocean Springs, Mississippi: Gulf States Marine Fisheries Commission, 1983.

the deepest body and greatest preanal length of any larvae examined. Eye diameter was also greater than in any other taxa except *L. fasciatus* (Table 5).

There are some inconsistencies in the illustrations of *Menticirrhus* larvae by Jannke (1971). Jannke illustrated three *Menticirrhus* larvae he believed were *M. americanus* but noted a discrepancy in caudal fin shape between the two 6 mm SL specimens (p. 111, figs. 21B, C). There was also a difference in pigmentation, preopercular spination, and head shape between them. Therefore, I believe Jannke's (1971) illustrations were of different species and that the larva in his figure 21B more closely resembles his illustrations of *M. saxatilis* than those of *M. americanus*.

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Literature Cited

Ahlstrom, E. H., J. L. Butler and B. Y. Sumida. 1976. Pelagic stromateoid fishes (Pisces, Perciformes) of the eastern Pacific: kinds, distributions and early life histories and observations on five of these from the northwest Atlantic. Bull. Mar. Sci. 26: 285–402.

Chao, L. N. 1976. Aspects of systematics, morphology, life history and feeding of western Atlantic Sciaenidae (Pisces: Perciformes). Ph.D. Thesis, College of William and Mary, Williamsburg, Virginia. 342 pp.

———. 1978. A basis for classifying Western Atlantic Sciaenidae (Teleostei: Perciformes). NOAA Tech. Rept., NMFS Circ. 415. 64 pp.

Cowan, J. H., Jr. 1985. The distribution, transport and age structure of drums (Family Sciaenidae) spawned in the winter and early spring in the continental shelf waters off west Louisiana. Ph.D. Dissertation, Louisiana St. Univ., Baton Rouge. 182 pp.

Daniels, K. L. 1977. Description, comparison, and distribution of larvae of *Cynoscion nebulosus* and *Cynoscion arenarius* from the northern Gulf of Mexico. Master's Thesis, Louisiana St. Univ., Baton Rouge. 47 pp.

Darovec, J. E., Jr. 1983. Sciaenid fishes (Osteichthyes: Perciformes) of western peninsular Florida. Mem. Hourglass Cruises 6(3): 1–73.

Ditty, J. G. 1984. Seasonality of sciaenids in the northern Gulf of Mexico. Assoc. S.E. Biol. Bull. 31: 55.

———. 1986. Ichthyoplankton in neritic waters of the northern Gulf of Mexico off Louisiana: composition, relative abundance and seasonality. Fish Bull., U.S. 84: 935–946.

Fable, W. A., Jr., T. D. Williams and C. R. Arnold. 1978. Description of reared eggs and young larvae of the spotted seatrout, *Cynoscion nebulosus*. Fish. Bull., U.S. 76: 65–71.

Fahay, M. P. 1983. Guide to the early stages of marine fishes occurring in the western North Atlantic Ocean, Cape Hatteras to the southern Scotian shelf. J. NW Atl. Fish. Sci. 4: 1–423.

Finucane, J. H., L. A. Collins and J. B. McEachran. 1977. Ichthyoplankton/mackerel eggs and larvae. NOAA final report to BLM. Environmental studies of the south Texas outer continental shelf 1976. BLM Contract AA550-1A7-3. 484 pp.

Fruge, D. J. 1977. Larval development and distribution of *Micropogon undulatus* and *Leiostomus xanthurus* and larval distribution of *Mugil cephalus* and *Bregmaceros atlanticus* of the southeastern Louisiana coast. Master's Thesis, Louisiana St. Univ., Baton Rouge. 75 pp.

——— and F. M. Truesdale. 1978. Comparative larval development of *Micropogon undulatus* and *Leiostomus xanthurus* (Pisces: Sciaenidae) from the northern Gulf of Mexico. Copeia 1978: 643–648.

Ginsburg, I. 1929. Review of the weakfishes (*Cynoscion*) of the Atlantic and Gulf coasts of the United States, with a description of a new species. Bull. U.S. Bur. Fish. 45: 71–85.

Guest, W. C. and G. Gunter. 1958. The sea trout or weakfishes (genus *Cynoscion*) of the Gulf of Mexico. Gulf States Mar. Fish. Comm. Tech. Summ. 1: 1–40.

Harmic, J. L. 1958. Some aspects of the development and the ecology of the pelagic phase of the grey squeteaque, *Cynoscion regalis* (Bloch and Schneider) in the Delaware estuary. Ph.D. Thesis, Univ. Delaware, Newark. 164 pp.

Hildebrand, S. F. and L. E. Cable. 1930. Development and life history of fourteen teleostean fishes at Beaufort, N. C. Bull. U.S. Bur. Fish. 46: 383–488.

——— and ———. 1934. Reproduction and development of whitings or kingfishes, drums, spot, croaker, and weakfishes or sea trouts, Family Sciaenidae, of the Atlantic coast of the United States. Bull. U.S. Bur. Fish. 48: 41–117.

——— and W. C. Schroeder. 1928. Fishes of Chesapeake Bay. Bull. U.S. Bur. Fish. 43: 1–388.

Holt, J., A. G. Johnson, C. R. Arnold, W. A. Fable, Jr. and T. D. Williams. 1981. Description of eggs and larvae of laboratory reared red drum, *Sciaenops ocellatus*. Copeia 1981: 751–756.

Irwin, R. J. 1971. Geographical variation, systematics, and general biology of shore fishes of the genus *Menticirrhus*, Family Sciaenidae. Ph.D. Dissertation, Tulane Univ., New Orleans, Louisiana. 289 pp.

Jannke, T. E. 1971. Abundance of young sciaenid fishes in Everglades National Park, Florida, in relation to season and other variables. Univ. Miami Sea Grant Tech. Bull. 11: 1–128.

Johnson, G. D. 1978. Development of fishes in the mid-Atlantic Bight: an atlas of egg, larval and juvenile stages, Part IV: Carangidae through Ephippidae. U.S. Fish. Wildl. Ser., Office of Biol. Sci. FWS/OBS-5-78/12. 314 pp.

Joseph, E. B., W. H. Massman and J. J. Norcross. 1964. The pelagic eggs and early larval stages of the black drum from Chesapeake Bay. Copeia 1964: 425–434.

Kuntz, A. 1914. The embryology and larval development of *Bairdiella chrysura* and *Anchovia mitchilli*. Bull. U.S. Bur. Fish. 33: 1–19.

Lippson, A. J. and R. L. Moran. 1974. Manual for identification of early developmental stages of fishes of the Potomac River estuary. Power Plant Siting Program, Maryland Dept. Nat. Resourc. PPSP-MP-13. 282 pp.

Matsuura, Y. and K. Nakatani. 1979. Ocorrenacias de larvas e jovens de peixes na ilha anchieta (sp), com algumas anotagoes sobre a morfologia da castanha, *Umbrina coroides* Cuvier, 1830. Bol. Inst. Oceanogr., Sao Paulo 28: 165–183.

Mohsin, A. K. M. 1973. Comparative osteology of the weakfishes (*Cynoscion*) of the Atlantic and Gulf coasts of the United States (Pisces-Sciaenidae). Ph.D. Dissertation, Texas A&M Univ., College Station. 147 pp.

Pearson, J. C. 1929. Natural history and conservation of redfish and other commercial sciaenids of the Texas Coast. Bull. U.S. Bur. Fish. 44: 129–214.

———. 1941. The young of some marine fishes taken in lower Chesapeake Bay, Virginia, with special reference to the gray sea trout *Cynoscion regalis* (Bloch). Fish. Bull., U.S. 50: 79–102.

Perlmutter, A. 1939. A biological survey of the salt waters of Long Island, 1938. Part II, Section I. An ecological survey of young fish and eggs identified from tow-net collections. N.Y. Conserv. Dept. Salt-water Survey 1938. 15: 11–71.

Posgay, J. A., R. R. Marek and R. C. Hennemuth. 1968. Development and tests of new zooplankton samplers. Int. Comm. North Atl. Fish. Res. Doc. 68/85. 7 pp.

Powell, A. B. and H. R. Gordy. 1980. Egg and larval development of the spot, *Leiostomus xanthurus* (Sciaenidae). Fish. Bull., U.S. 78(1): 119–136.

Powles, H. 1980. Descriptions of larval silver perch, *Bairdiella chrysoura*, banded drum, *Larimus fasciatus*, and star drum, *Stellifer lanceolatus* (Sciaenidae). Fish. Bull. U.S. 78(1): 119–136.

———. 1981. Eggs and larvae of North American Sciaenid fishes. Pages 99–109 *in* H. Clepper, ed. Marine recreational fisheries: 6. Proc. Sixth Ann. Mar. Recr. Fish. Symp., Sport Fish Inst., Washington, D.C. 216 pp.

——— and W. E. Burgess. 1978. Observation on benthic larvae of *Pareques* (Pisces: Sciaenidae) from Florida and Colombia. Copeia 1978: 169–172.

——— and B. W. Stender. 1978. Taxonomic data on the early life history stages of Sciaenidae of the South Atlantic Bight of the United States. S. Car. Mar. Resourc. Center, Techn. Rept. No. 31. 64 pp.

Renfro, W. C. 1963. Small beam net for sampling postlarval shrimp. Pages 86–87 *in* Biological Laboratory, Galveston, Texas, fishery research for the year ending June 30, 1962. U.S. Fish. Wildl. Serv. Circ. 161: 1–101.

Robins, C. R., R. E. Bailey, C. E. Bond, J. E. Brooker, E. A. Lachner, R. N. Lea and W. B. Scott. 1980. A list of common and scientific names of fishes from the United States and Canada. Amer. Fish. Soc. Spec. Publ. 12 (4th ed.). 174 pp.

Sabins, D. D. 1973. Diel studies of larval and juvenile fishes of the Caminada Pass area, Louisiana. Master's Thesis, Louisiana St. Univ., Baton Rouge. 163 pp.

Scotton, L. N., R. E. Smith, N. S. Smith, K. S. Price and D. P. de Sylva. 1973. Pictorial guide to fish larvae of Delaware Bay, with information and bibliographies useful for the study of fish larvae. Delaware Bay Rep. Series, Vol. 7, College Marine Studies, Univ. Delaware. 206 pp.

Simmons, E. G. and J. P. Breuer. 1962. A study of redfish, *Sciaenops ocellata* Linnaeus and black drum, *Pogonias cromis* Linnaeus. Publ. Inst. Mar. Sci., Univ. Texas 8: 184–211.

Stender, B. W. 1980. Descriptions, illustrations, and distribution of the early life history stages of *Cynoscion nothus,* with notes on related species. Master's Thesis, College of Charleston, South Carolina. 55 pp.

Tracy, H. C. 1908. The fishes of Rhode Island. VI. A description of two young specimens of squeteague (*Cynoscion regalis*) with notes on their rate of growth. RI Comm. Inland Fish. Annu. Rept. 38: 85–91.

Walker, H. J., Jr. 1978. Ichthyoplankton surveys of nearshore Gulf waters between Barataria Bay and Timbalier Bay, Louisiana, during July, August, and December, 1973. Master's Thesis, Louisiana St. Univ., Baton Rouge. 59 pp.

Weinstein, M. P. and R. W. Yerger. 1976. Protein taxonomy of the Gulf of Mexico and Atlantic Ocean seatrouts, genus *Cynoscion.* Fish. Bull., U.S. 74: 599–606.

Welsh, W. W. and C. M. Breder, Jr. 1924. Contributions to life histories of Sciaenidae of the eastern United States coast. Bull. U.S. Bur. Fish. 39: 141–201.

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